Fire Program Analysis
Preparedness Module

Pre-Course Work
February 2006

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Course Description

Fire Program Analysis Preparedness Module (FPA-PM) is an instructor-led course intended to be presented at the geographic area level. This course is designed to support the training requirements of interagency Fire Planning Units in completing fire management planning and budget analysis processes specific to that unit. The course lessons and exercises support training for fire planners and others charged with editing and inputting information into the FPA-PM system, fire and resource management staff who apply FPA-PM outputs to fire management decision making, and planners at the state/regional and national levels who manage the FPA system. Approximately one-half of the course is devoted to skills development and data management exercises on the computer.

The course contains the following software programs

- **FPA-HA** – (Historical Analysis) the purpose is the review and validation of fire occurrence and weather data for use in the creation of a fire event scenario.
- **FPA-PM** – (Preparedness Module) an automated system for initial attack planning to replace the systems previously used by the five federal wildland fire management agencies. FPA-PM will evaluate the cost effectiveness of alternative initial attack organization in meeting multiple fire management objectives.
- **FPA-BDD** – (Budget Development and Delivery) used to integrate FPA-PM analysis results with the existing organization to develop an out year budget request for fire preparedness.

This pre-course work package has been developed to prepare students for terms and concepts used in the classroom, the assumptions and business rules used in the Preparedness Module model, and the factors that led to the development of the FPA System.

Course Objectives

- Provide the knowledge required to develop inputs for FPA-PM Analysis
- Provide skills and knowledge to run the FPA Preparedness module program
- Provide the knowledge to interpret the results of FPA-PM analysis.
- Describe how the FPA budget analysis process fits in with the larger budget and planning process

Student Prerequisites

This training is required for individuals who will edit or administer data for the Fire Program Analysis System. Students should be employed in positions whose duties include editing, managing and interpreting Fire Program Analysis data.

Recommended training to supports preparation for FPA-PM:

- Intermediate to advanced personal computer skills (file management, Microsoft Word and Excel)
- Beginner to intermediate experience with GIS systems
- Introduction to Wildland Fire Behavior Calculation, S-390
- Advanced Wildland Fire Behavior Calculations, S-490
- Intermediate National Fire Danger Rating System, S-491

The course coordinator has established enough time to contact you about the course requirements and deadline for return of completed pre-course work; for the cadre to grade completed pre-course work results; and notify you of selection or non-selection for the classroom portion of the course. The combined minimum passing score for all pre-course work quizzes is 70%.

Only those students who <u>complete</u> the pre-course work by the deadline established in the course notification letter and have a passing score (70%) will be accepted into the classroom portion of the course.

The pre-course work for FPA-PM consists of the following components:

- **FPA Overview and Purpose –** Provides background information on the development of the FPA program.
- **FPA Philosophy of Modeling Fire Preparedness –** Describes theoretical concepts used in FPA for modeling fire preparedness.
- **Review of Fire Behavior Principles –** A review of fuel types, fuel models and fire behavior model inputs and how they relate to the FPA system. Some of the questions in the quiz relate back to the suggested training found in the S-290, Intermediate Wildland Fire Behavior course.
- **White Paper Overview –** A series of questions that focus the student's reading through white papers and reports located on the FPA website. The links in the study guide take the student to the specific document that covers the topic.
- **Gaining an Understanding of the NFDRS** - The publication provides the background needed to prepare the student on the history, components, and application of the National Fire Danger Rating System. The publication may be downloaded from http://www.nwcg.gov/pms/pubs/MasterGaining.pdf
- **Pre-Course Work Quiz –** prepares the student with the following information:
    - background information on the FPA system;
    - the concepts involved with modeling the preparedness portion of the fire management program;
    - the business rules and assumptions that guide the model calculations;
    - for discussion and application of fire behavior inputs;
    - apply NFDRS terms and concepts as they relate to FPA-PM

FPA Glossary of terms:

You will need to refer to the FPA glossary throughout the training. The complete glossary is located at http://www.fpa.nifc.gov/Library/Documentation/fpa_glossary.xls

Main terms to understand;

- Fire Planning Unit (FPU)
- Fire Management Unit (FMU)
- Fire Intensity Level (FIL)
- Sensitivity Period
- Weighted Acres Managed (WAM)
- Fire Event Scenario
- Weights

FPA –Overview and Purpose

The purpose of the Fire Program Analysis (FPA) System is to provide managers with a common interagency process for fire management planning and budgeting to evaluate the effectiveness of alternative fire management strategies through time to meet land management goals and objectives. FPA will be driven by quantified fire objectives and performance measures for the full scope of fire management activities.

The new FPA application will allow for landscape scale, interagency analysis at the planning unit level. This analysis will result in agency budget submissions as well as a national database of alternative budget levels, suppression organizations, objectives and associated outputs. The comparison of outputs to objectives is an indicator of effectiveness.

The project will re-engineer the business process so that all five federal agencies will utilize the same fire management budget request process, models, assumptions and displays. Budget alternatives will be rolled up across all the agencies to a national database to facilitate analysis of the preparedness budget across and between agencies.

The FPA System Preparedness Module is the first in a series of modules to be developed. The first module will involve developing an automated system for initial response planning to replace the systems currently in use by the five federal wildland fire management agencies. The Preparedness module will evaluate the cost effectiveness of alternative initial response organizations in meeting multiple fire management objectives.

Additional FPA System modules will address preparedness, extended attack, large fire, hazardous fuels, prevention/education, and burned area emergency rehabilitation

The agencies are:

- USDA Forest Service (USFS)
- DOI Bureau of Land Management (BLM)
- DOI National Park Service (NPS)
- DOI Fish & Wildlife Service (FWS)
- DOI Bureau of Indian Affairs (BIA)

Background

The Interagency Federal Wildland Fire Policy developed in 1995 and reaffirmed in 2001, the 10-year Comprehensive Strategy, and the Hubbard Report, all recommend developing a common interagency budget analysis system for the federal wildland fire community. Further direction from Congress and the executive branch mandated that a system be developed.

Presently, several fire analysis systems guide fire planning efforts; each is designed to meet specific agency missions. While these systems have been fairly effective, they do not easily promote interagency planning and budget formulation across agency and departmental boundaries. Because of this limitation, these systems have not adapted to meet the needs of today's complex fire management organization, with its expanded mission.

Highlights

The new system will provide the following:

- Support interagency, landscape level preparedness planning and budgeting.
- Be driven by land management and fire management objectives.
- Analyze the cost effectiveness of fire suppression staffing alternatives.
- Be used by all federal land management agencies for fire preparedness planning.
- Use the cost effectiveness of meeting multiple fire management objectives as the decision criteria.
- Facilitate comparison of organizational effectiveness across planning units through an array of choices for any budget level.
- Include regional and national resources and program management needs.

Approach

The FPA system will use optimization to determine the level of effectiveness associated with a range of budgets. The new approach to initial attack budget analysis will use fire management cost as an input to the model. Application of this feature is directly in line with direction to develop an analysis system that uses budgets as an input. The approach enhances current methods where analysts input alternative staffing levels to determine associated budgets.

Real World vs. Model World

The following is from the *Implementing Modeled Results in the Real World* FPA White Paper.

The Model World: Analyzing the fire program is complicated. Experienced wildland fire decision-makers are familiar with the multitude of variables that affect wildland fire decisions and the high degree of uncertainty that accompany them. Since the fire management program is a complex system, we use models to represent that system in an attempt to aid us in the decision making process. A model can be defined as, "*a purposeful representation of the real world.*" By definition, every model is an abstraction of reality that enables the user to simplify the problem while retaining those factors that are most important to generate the desired outcome. Therefore, this model should be judged on its ability to produce an annual budget and an annual list of fire resources. The FPA purpose is to adequately address the workload and performance goals of most Fire Planning Units (FPU). There will always be some programs that are outliers and will require adjustments to model outputs

We have defined the initial response to wildland fire in the context of a resource allocation problem across an entire fire season for a single Fire Planning Unit (FPU). FPA attempts to answer the question: What is the optimal set of fire resources to have on hand for a single fire season at a given cost constraint? The optimization model employed by FPA-PM is an analytical technique that is often used to solve resource allocation problems such as this. The FPA system also uses other modeling techniques, such as simulation and expert opinion to model fire behavior and Fire Management Leadership, respectively. The outputs from this analysis can give us valuable insight into how the modeled world compares to the real world.

The Real World: The real world, which the FPA model attempts to represent, is much more complex. Unlike our model world, the real world does not know when and where fires will occur in the coming fire season, have homogeneous fuel types, constant slopes and weather, fires that occur at a single workload point, or predictable fireline production rates. Another distinction between the modeled world and the real world is that the model world only analyzes the initial response to wildland fires and not the full fire management program.

These differences highlight the fact that the outputs from FPA (model world) will be used to begin a dialog about strategic fire resource allocation. By themselves, FPA outputs are not the decision about FPU fire resource allocation.

Interpretation: The fact that the real world varies from the modeled world does not invalidate the FPA analysis. The value of any model is in providing insight and understanding of the real world.

The modeled results should be viewed as a good starting point for discussions between modelers and decision makers; or in the case of FPA, results in a discussion between fire planners, fire managers, and agency administrators. These discussions should lead to greater understanding of the system being modeled. Managers and Agency Administrators will very likely ask questions that could be illuminated by analyzing additional scenarios within the FPA model.

The modeled results of FPA will be used to develop and eventually deliver budget information to local units. A tremendous amount of input and output data can be reported by the FPA system.

Implementation Expectations: FPUs should expect to implement their fire management program through an organization that is “close” to the optimal solution. Stated another way the real world organization should have similar capability to the model world solution. It does not have to be the exact solution as identified by FPA-PM. Our real-world organizations contribute to the full array of fire management program components (extended attack, large fire support, fuels management etc.) The first phase of the FPA model only analyzes the initial response part of the fire management program. Although changing the mix of staffing and resources in existing organizations is always difficult, such changes might occur at any time if Congress increases or decreases wildland fire budgets for reasons having nothing to do with FPA. FPA will provide an objective basis for change, and empowers local FPUs to develop plans for phasing in changes and modifying the FPA-identified mix of resources with proper rationale.

The FPA development team and FPA Steering Committee have long recognized that the FPA solution cannot and should not be instantly implemented. National and local transition strategies need to be developed, [the National Transition Strategy document is on the FPA website]. The outgrowth of local strategies will be detailed transition plans, which provide a rationale built on the FPA results that transition the current fire management organization into a more cost-effective organization of the future.

Philosophy of Modeling Fire Preparedness

Objectives:

- Identify key philosophical elements of FPA.
- Discuss the reasons for an interagency approach and how it fits the overall philosophy of FPA.
- Define the role of performance-based planning as a philosophical cornerstone of the system.
- Discuss optimization as a philosophical statement about the relationship between cost and performance, identify inefficient points, and explain how optimization differs from simulation.
- Provide background of how the performance-based system relates to elements of land and fire management planning.

Core Concept

There are significant differences between the previously used budget planning tools and FPA. The most important thing for a fire planner to understand is that the results from FPA-PM may not reflect existing or past organizations. In addition, this tool requires the user to correctly frame or construct the situation to get meaningful results.

New Paradigm

"A new paradigm of fire management has arrived that has potentially profound implications for the future of our fire program analysis systems. The new paradigm carries broader responsibilities, heightened expectations, and increased costs, and it almost certainly will increase public expectations for program performance and accountability.

A new programmatic foundation is required to support the central role of fire on our nation's public lands and address wildland fire within the context of broad land management goals." (Rideout and Botti, 2002)

Theoretical Design

The theoretical underpinnings of FPA differ significantly from previous systems. The primary difference between FPA and previous modeling systems is the way the economic model works in evaluating performance based on weighted acres managed (WAM) vs. costs. Because FPA uses a significantly different approach, the results from the optimization model may not reflect current or past decisions.

Understanding the philosophy of FPA puts this theory into context. In this lesson, we will do the following:

- explore the philosophical underpinnings of FPA
- explain why a different philosophical approach has been adopted by the agencies and engineered into the system
- explain how the FPA philosophy operates within the land and fire management planning environment.

Elements of the Philosophy

Three important areas reflect this difference in philosophy.

- A single interagency system
- Performance-based planning and budgeting
- Optimization programming

Each one is intended to enable and support better decisions, as well as a providing a credible budget and allocation process.

Together, these philosophical changes reflect the availability of new computing technology, a comprehensive and sound economic theory, and recent legislation. While the philosophy and tenets of performance-based planning and budgeting provide the cornerstone of the new philosophical approach, we will first look at using a single interagency system because it will help us understand the other two. Let's take a look at each element starting with the interagency perspective.

Single Interagency System

At the outset, fire management leadership stressed the importance of using a single interagency system, similar to that described by Rideout and Botti (2002). The FPA philosophy reflects the reasons for this important change:

- Allow consolidation of techniques and tools
- Improve technical efficiencies
- Facilitate communication processes and cost analysis.

Agencies were using a suite of different planning and budgeting techniques, which caused concerns and raised questions at Departmental levels, as well as in Congressional committees and OMB.

Suggestions for consolidating approaches to streamline the overall process and to provide consistency in approach and analysis became a consistent theme at the highest levels of government and part of implementing the new wildland fire policy (USDOI and USDA 2001).

On the operations side, technical efficiencies in initial response could be achieved by formally including agency cooperation.

The elements of interagency cooperation include the following capabilities:

- Response to events in ways that can take advantage of the interagency approach (in some instances); i.e., ICS closest forces
- Use of a larger pool of resources and talent by forming larger interagency fire planning units.
- Increase in scale to take advantage of the cost efficiencies

Such elements form a cornerstone of projected cost savings and efficiencies operating under the new philosophy. While the field used some of these elements in normal operations, a formal process for organizing, planning, and implementing interagency cooperation on a larger scale could promote more efficient management and corresponding cost savings.

From an economic perspective, formally consolidating agency efforts improves efficiency through better and more consistent information processes, and improves the cost analysis of equipment and personnel used in multiple settings.

The interagency approach has important social implications as well. Aside from potentially different agency cultures, we needed to address performance broadly enough to encompass the varied missions of the different agencies, but specifically enough to consider the resource impacts that could occur on a particular planning unit.

Performance-based planning

Performance-based planning required a common performance measure suitable for all agencies that can also reflect differences between agencies with diverse missions where some stress non-monetized management.

Constructing this bridge, from national-level performance to unit-specific impacts and across all agencies, required the construction of a special process that supported a common metric of performance.

The weight system, Expert Opinion Weight Elicitation Process (EOWEP) (Rideout and Ziesler 2004) was specifically developed to support performance-based planning in FPA. Under proper implementation and by following the established rules of weight elicitation, EOWEP will support and enable the new fire management paradigm operating under the FPA philosophy.

Performance-based planning is the single most important philosophical change in this planning system. Developing an innate understanding of this philosophy is crucial to your understanding of the context and operation of the model.

In its simplest form, performance-based planning means two things:

- Measuring performance in physical rather than monetary terms
- Establishing a functional relationship between performance and cost or budget allocation/appropriation as shown in Figure 1.

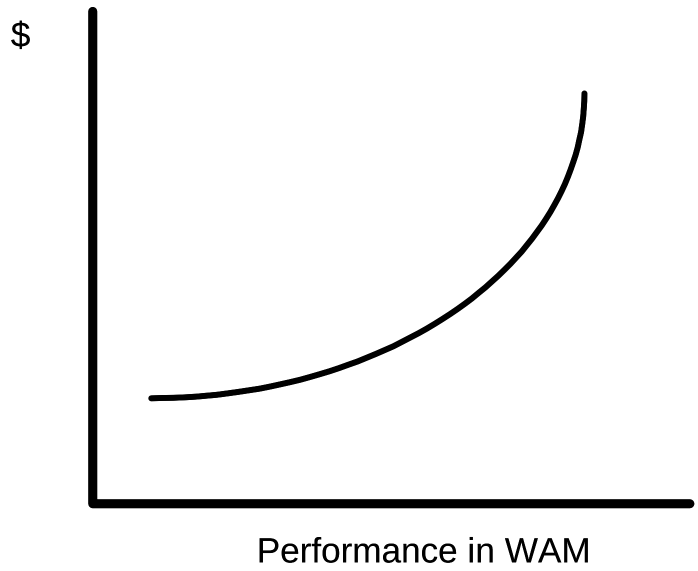

Figure 1: Cost vs. WAM

In Figure 1, you can visualize how increasing cost or appropriation produces increasing levels of performance.

This key construct of the model allows you to identify this tradeoff and to show how increases (or decreases) in cost can increase (or decrease) expected performance.

This brings up two more crucial philosophical points:

- The functional relationship between cost and performance is established by the integer linear program (ILP)
- There is no such thing as a “most efficient point” or level in this model. There can no longer be a “MEL” in the FPA budget philosophy.

The first point is discussed in the next section and in the lesson on optimization, but the main point of the ILP is to directly calculate the points on the curve in Figure 1. Doing so avoids the inefficient interior points (to the left of the upward sloping function).

The second point, that there is no such thing as a most efficient level, reflects the fact that the model is designed to identify how much performance can be attained at different budget levels.

In this way, the model directly reflects and informs the appropriation process. Given the menu of cost and performance (Figure 1) at the national level, an appropriation can be associated with a particular performance point. This point is only known after the appropriation is made.

Before the appropriation occurs, we use the menu of points shown on the curve. The results of your unit level FPA analysis will generate performance and cost pairs that result in a curve similar to the one shown in Figure 1. The curve shown in Figure 1 should resemble your final results.

Don’t be deceived about the simplicity of the philosophy. Underlying the philosophy is a whole set of variables, complex decisions, tradeoffs, and relationships that you will be using in your FPA analysis.

For example, you will need to know at each cost level, how many fires were contained, which firefighting resources were deployed, where they were deployed, and much more. You can also think of Figure 1 as applying to the national program. By aggregating separate analyses from each FPU, a similar figure can be produced to reflect the national program.

To engineer a system based on performance-based planning, we need a clear definition of performance that can be applied across the agencies.

The metric of weighted acres managed (WAM) accommodates this need. This reflects the notion that, in initial response, we are protecting (initial response) or improving (wildland fire use) acres.

The weighting system reflects the concept that acres differ in their importance to protect, and this difference needs to be reflected in the performance measure.

Optimization Philosophy

This will likely be the first system that you have used that directly uses optimization technology. We will review optimization as a philosophy, and discuss how it differs from the simulation model.

Simulation models are designed to reflect conditions in some natural or man-made system to enable better understanding of the system and its relationships. Models also allow us to model a natural system (like a fire) without having to actually interact with the system (like starting a fire). In fire planning, fire behavior simulation is a well-known example, and some of this information is used to provide input to the optimization process. Previous systems, including NFMAS, were based on simulation and extensive sensitivity analysis.

FPA, on the other hand, is based on optimization. In optimization, we ask the computer program to find the most efficient allocation of resources instead of simulating past behavior. For example, we want to know the best list of firefighting resources, as well as the best deployment opportunities for those resources to maximize performance at a given cost level.

Key Point: In optimization, we are not trying to simulate how decisions have been made, but instead, we are modeling how to best make decisions. Here, we bring new and stronger technology to the problem. By applying optimization we will, for the first time, be able to avoid all of those planning options that might occur on the interior of the frontier in Figure 1.

Importantly, optimization rests the burden of calculation on the computing technology instead of the user. For the user, it is all about properly framing the FPU situation.

Planning Considerations and the Philosophy of FPA

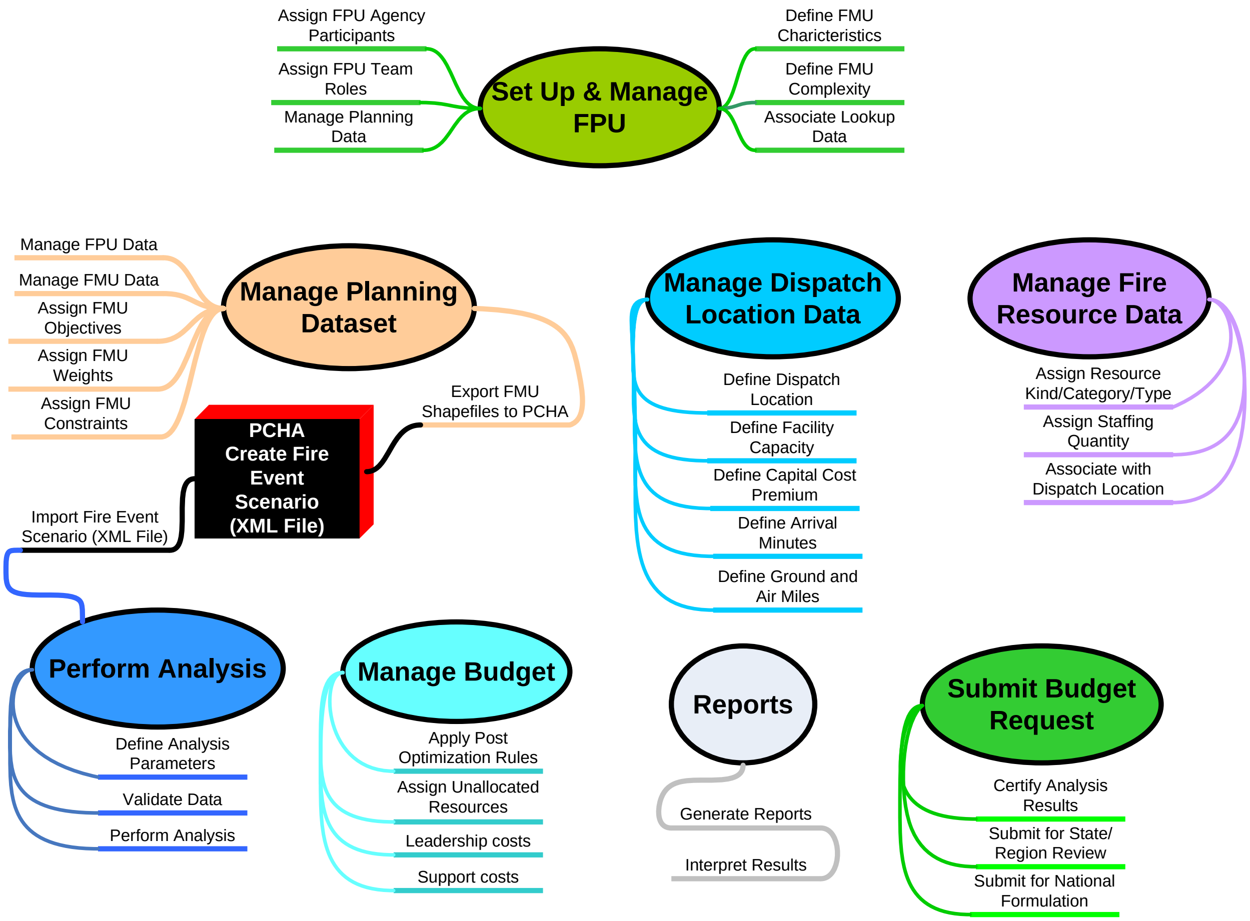

Figure 2: General Process Flow for PM

The FPA system brings new information to the fire planning and budgeting process, while including a broadly defined measure of performance. Like previous systems, FPA operates within the context of the land and fire management plans, which mean that much of the data used as inputs in the previous system are still valid for FPA. However, the results may be different because the assumptions and theory behind the model are different.

We should be clear about the planning goals and/or objectives and how they are included in the FPA philosophy. You will likely see statements of goals or objectives in planning and want to know how they fit relative to the performance-based application of FPA. Remember, the FPA system is designed to manage tradeoffs to maximize performance at a given budget/cost level. Not all goals and objectives (especially ones stated as fixed amounts) can possibly be met at all budget levels.

We need a model that can manage the tradeoffs, to best accomplish performance with both limited and abundant resource availability. In the context of Figure 1, limited resource availability would be reflected by options near the origin, while abundance is suggested at options at the upper right of the curve.

Statements of goals or objectives are managed within the system. For example, you may want to achieve a certain percentage success rate in Initial Response (IR) for a given unit.

FPA solves for the IR success rate that will provide the most performance at different budget limitations. In this way, we might see the IR success rate rise or fall as performance increases. This change could occur as the model has funds to contain fires affecting acreage that is more important. In other words, the goals and objectives are managed relative to the broader performance measure of WAM.

The system is designed to report levels of physical effects that relate to the planning goals. This capability allows you to observe changes in physical conditions related to planning goals/objectives, and to understand how they might change as the budget/cost changes in the context of an attribute-based system.

The planning process informs the attribute-based system. The alternative (to using a broad performance measure) of programming all of the different fixed goals/objectives that might occur across the nation and across all agencies is infeasible. Remember that the planning material provides the context for, informs, and is reflected throughout various elements of the FPA system.

Literature Cited

Rideout, Douglas B. and Stephen J. Botti. 2002. Performance-based interagency fire program analysis: blueprint for planning. Journal of Forestry. 100(5):36-41.

Rideout, Douglas B. and Pamela S. Ziesler. 2004. The R-Z Weight System (EOWEP) for FPA-PM (An Abstract). Working Draft Version 2.0. Fire Economics Laboratory, Department of Forest, Rangeland and Watershed Stewardship, Colorado State University. Available at http://taurus.cnr.colostate.edu/projects/fel/ until replaced by a newer version.

US Department of Interior (USDI) and US Department of Agriculture (USDA). (2001). Review and Update of the 1995 Federal Wildland Fire Management Policy. 78.

Review of Fire Behavior Principles

Objectives:

- Identify basic components of fire behavior; fuels, weather, and topography
- Define a fuel model and a fuel type as used in FPA.
- Describe the modeling process for surface fire behavior including inputs, outputs, limitations and assumptions.
- Describe the three fire types
- Define the Fire Intensity Level (FIL).
- Describe the use of the Fire Behavior Prediction System (FBPS) and the National Fire Danger Rating System (NFDRS) components in FPA.
- Describe the fire containment process used in FPA-PM

Identify Basic Components of Fire Behavior, Fuels, Weather, and Topography

From the first fire behavior training classes that personnel take through the most advanced training, fire behavior prediction is taught based on the knowledge of the fire triangle: fuels, weather and topography.

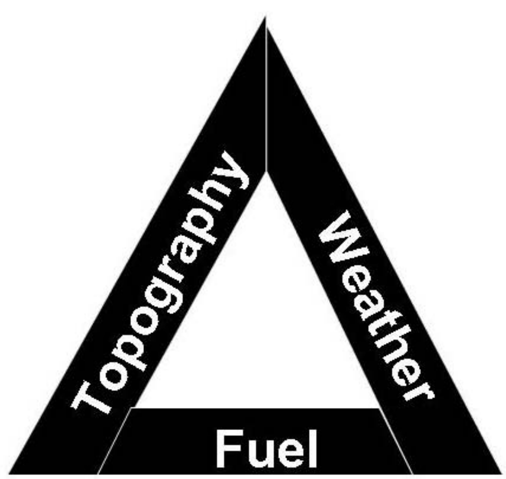

Figure 3: The Fire Behavior Triangle

Fuels

Fuel is any organic material that is living or dead that can ignite and burn.

Fuel strata: A way to classify fuels vertically is to divide them into three broad groups.

- **Ground fuels:** All combustible materials lying beneath the surface including dead duff, roots, rotten buried logs and other woody fuels
- **Surface fuels:** All materials lying on or immediately above the ground including needles or leaves, duff, grass, small dead wood, downed logs, stumps, large limbs, low shrubs and reproduction. In general, surface fuels are located from 0 to 6 feet above ground level.
- **Aerial fuels:** All combustible materials located in the upper forest canopy including tree branches and crowns, snags, moss, and tall shrubs. In general, aerial fuels are greater than six feet above ground level.

Fuel categories

Organic fuels can be both dead and live.

- Dead Fuels: Fuels that are dead normally occur in the surface fuels, but they can also be in the aerial and ground fuel profiles.
- Live Fuels: Living organic material can be a heat sink or a heat source. It is a heat source when there is enough fire intensity for moisture to be driven off allowing it to burn, contributing to the overall intensity of a fire.
    - Herbaceous: Herbaceous fuels are composed of grasses, forbs and lichens.
    - Woody (Shrub): Woody fuels are the twigs and branches of shrubs.

Dead fuel size class definitions

Based on the ability to absorb and release moisture, dead fuels are divided into four size class categories.

- **1-h timelag fuels:** The one-hour (1-h) timelag fuel category includes fuels from 0 to 0.25 inches (0.64 cm) in diameter. This includes needles, leaves, cured herbaceous plants and fine dead stems of plants. As these are the finest sized fuels, they are the most important when fire spread is predicted.
- **10-h timelag fuels:** The ten-hour (10-h) timelag fuel category includes fuels from 0.26 to 1.00 inch (0.64 to 2.54 cm) in diameter.
- **100-h timelag fuels:** The hundred-hour (100-h) timelag fuel category includes fuels from 1.01 to 3.00 inches (2.54 to 7.62 cm) in diameter.
- **1000-h timelag fuels:** The thousand-hour (1000-h) timelag fuel category includes fuels from 3.01 to 8.00 inches (7.62 to 20.3 cm) in diameter.

Fuel moisture

The moisture content of dead and live fuels is expressed as a percent. It is calculated as:

$$\text{Fuel Moisture (\%)} = \frac{\text{Wet weight - Dry weight}}{\text{Dry weight}} * 100$$

Aerial (Canopy) fuels

Aerial fuels are those six feet above ground level. The weight of small diameter dead and live fuel in the crowns of trees is very important in the assessment of crown fire potential. Also important in this assessment is the vertical location of this material in the canopy as a whole. These factors are quantified for a stand by three values.

Canopy base height (CBH): For an individual tree, the measurement of the height to the base of the crown. The averaging of these values for all trees in a stand gives an estimate of the level of the stand canopy base height. Frequently, this is a measure of where the limbs of the canopy start vertically but the number can be skewed by the presence of small trees or occasional live limbs. A more meaningful value is the height above the ground of the first canopy layer where the density of the crown mass within the layer is high enough to support vertical movement of a fire.

Canopy bulk density (CBD): Mathematically, canopy bulk density (lbs/ft3) is canopy biomass divided by the volume occupied by crown fuels. Canopy bulk density is hard to estimate in the field. Initially, it seems attractive to calculate this value by treating the canopy as a box with the depth of the stand height minus the canopy base height. Assuming a box covers an acre (43,560 ft2), dividing the fuel loading in the canopy by the volume of box would provide an estimate of average canopy bulk density. Unfortunately, this estimate has a bias toward underestimation of the canopy bulk density due to the averaging of largely void areas in the top and bottom of the canopy with the more dense layers of foliage. A fire burning vertically within the crowns will most likely propagate through denser canopy layers.

Stand height (SH): For an individual tree, the measurement of the height is from the ground to the top of the tree tip. The averaging of these values for all of the trees in a stand provides an estimate of the stand height.

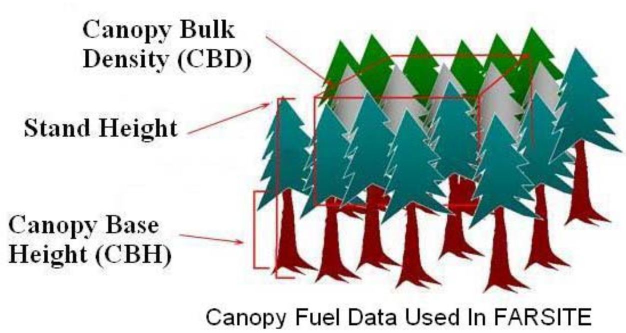

Figure 4: Canopy Fuel Data

Fuel Model

Definition of a Fuel Model

A fuel model is set of attributes for a fuelbed that provide inputs to fire behavior prediction equations.

1982 FBPS Surface Fuel Models

The 1982 FBPS surface fuel models (Table 1) are classified into four broad types based on the fuels that are the primary carrier of the fire (grass, brush, timber, and slash). Surface fuels can be further classified into "fuel models." The 1982 FBPS fuel models are identified in Table 1.

Table 1: FBPS Fuel Models

CFuel Group	FBPS Fuel Model
Grass	1 - Short Grass (1 foot)
	2 - Timber (Grass and understory)
	3 - Tall Grass (2.5 feet)
Brush	4 – Chaparral
	5 – Brush
	6 - Dormant Brush
	7 - Southern Rough
Timber Litter	8 - Closed Timber Litter
	9 - Hardwood (pine long needle litter)
	10 - Timber
Slash	11 - Light Slash
	12 - Medium Slash
	13 - Heavy Slash

See Anderson, Aids to Determining Fuel Models for Estimating Fire Behavior (GTR INT-122, NFES 1574) for a full description of each fuel model's defining characteristics.

The FBPS is designed to allow short-term, site specific predictions to estimate what fire behavior can be expected given the weather forecast, coupled with the existing topographic and fuel conditions. It has become a valuable fire management tool for:

- Estimating fire size and shapes at a given time
- Determining resource needs, fireline production rate requirements
- Placement of crews, helispots, and firelines
- Modeling effects of fire suppression alternatives
- Prescribed fire planning

The primary outputs of FBPS used in FPA are Rate of Spread (ROS) and Flame Length (FL).

NFDRS Fuel Models

Because of the need to reflect seasonality, new fuel models were developed for the NFDRS. There are 20 NFDRS fuel models (Table 2) and they are “lettered.” The table below identifies all the NFDRS Fuel Models with the corresponding FBPS Fuel Models.

Table 2: NFDRS Fuel Models

Fuel Group	NFDRS Fuel Model	FBPS Model
Grass	A – Western Annual Grasses	1
	C – Open Pine with Grass	2
	L – Western Perennial Grasses	2
	N – Sawgrass	2
	S – Tundra	1
	T – Sage with Grass	1
Brush	B – Mature Brush (6 feet)	6
	D – Southern Rough	4
	F – Intermediate Brush	7
	O – High Pocosin	4
	Q – Alaska Black Spruce	6
Timber Litter	E – Hardwood Litter (Fall)	9
	G – Heavy Short Needle Timber Litter	10
	H – Normal Short Needle Timber Litter	8
	P – Southern Long Needle Pine Litter	9
	R – Hardwood Litter – Spring/Summer	8
	U – Western Long Needle Litter	9
Slash	I – Heavy Slash	13
	J – Medium Slash	12
	K – Light Slash	11

The NFDRS relates only to the potential of an initiating fire. The system considers the probability of fire occurrence and the "relative" aspects of fire behavior. Its calculations are based on long-term weather observations and applied to large areas (tens to hundreds of thousands of acres).

The ratings are relative versus absolute. The indices calculated by the NFDRS are based on one weather observation per day. This observation is taken at 1:00 p.m. local standard time. The NFDRS calculations are based on a defined combination of fuel model, slope class, climate class and vegetative type that are uniform for the entire danger rating area. For these reasons, the indices calculated should not be used in an absolute sense. For example, the Spread Component (SC) is calculated using essentially the same equations that comprise the Rothermel spread model. The SC is the theoretical rate of spread in feet per minute given the inputs of weather (weather observation and climate class for the danger rating area), fuels (generalized fuel model and vegetative class for the danger rating area), and topography (generalized slope class for the danger rating area).

Worst-case conditions are assumed. Since the weather observation is taken at 1:00 p.m., local standard time, and the weather station is on a south aspect in an open area, the inputs to the index calculations are using worst-case values.

Use of FBPS and NFDRS fuel models in FPA

A fuel type in FPA is a unique combination of the following:

- Canopy cover: the percent area occupied by the vertical projection of tree crowns
- Surface (FBPS) fuel model: These are the 13 FBPS fuel models displayed in Table 1
- Canopy base height (CBH)
- Canopy bulk density (CBD)
- Stand height (SH)

Values to Use for CBH and CBD

For values that are reasonable for the FPU, consult with fire behavior specialists familiar with defining these values. Also, consult the publication Stereo Photo Guide for Estimating Canopy Fuel Characteristics in Conifer Stands (Scott and Reinhardt 2005). A utility in PCHA calculates fire behavior using all five attributes of a fuel type and three attributes of a topographic type.

An NFDRS fuel model is assigned to each FMU. One assignment is based on the fuel model used in the FMU to develop NFDRS criteria (ERC or BI) which is used in the Wildland Fire Use decision criteria for fire events. The other assignment is the fuel model that will be used to stratify historic weather conditions and to develop a probability matrix for the probability of a fire event on a day within each sensitivity period. Note that for estimated fire spread and intensity for a fire event, PCHA uses the surface FBPS fuel model.

The default fuel model for the ERCFM (ERC Fuel Model) is NFDRS fuel model G. Fuel model G is unique in that it has non-zero fuel loading values for all six-fuel categories (1-h, 10-h, 100-h, 1000-h, herbaceous and woody). The NFDRS indices calculated use NFDRS fuel model G to allow the effect of fuel moisture values in all six-fuel categories.

Weather

Weather processes determine the moisture content of live and dead fuels. All of these processes are critical inputs to the prediction of fire behavior.

Fuel Moisture and Fuel Moisture Scenarios

The fuel moisture of the dead and live fuel categories at an NFDRS weather station is either measured or predicted by equations from recorded weather inputs, such as temperature, wind and relative humidity. A collection of fuel moisture values for all six categories (1-h, 10-h, 100-h, and 1000-h, herbaceous and woody) is called a fuel moisture scenario.

Wind Speed

- 20-foot Wind Speed - is taken at 20 feet above the vegetation
- Midflame Wind Speed is the wind speed that exists at midflame height above the fuel bed. The midflame height is often called eye-level.
- FPA uses a constant average wind speed of 7.2 mph for modeling fire growth

Weather Stations Used in Fire Danger Rating

Land management agencies predominantly use the National Fire Danger Rating System (NFDRS) to determine short term and long-term fire danger. NFDRS weather stations are sited to strict standards in order to obtain dependable weather data for each station.

Weather Observations

A weather observation is taken at NFDRS stations at 1:00 p.m. local standard time, each day. Many of these stations are automated and record additional weather observations hourly.

Adjustments in fuel moisture for differences in topographic attributes

Fuel moisture values may differ from the weather station site to a fire site.

Weather Station Attributes

NFDRS weather stations are deliberately situated at locations that will measure the driest conditions (south aspect). In addition, they are located in the open so are unsheltered from the general wind. Hence, fuel moisture values measured at or calculated from observations at a weather station might be dryer and windier than at a fire site.

FMU Attributes

The definition of an FMU includes values for average elevation and aspect.

Historic Fire Attributes

Agency fire reports contain data fields for slope, aspect and elevation for the fire site.

Fuel Moisture Adjustments

PCHA uses the same processes in the Fire Behavior Prediction System (FBPS) that are used to adjust the 1-h fuel moisture value calculated for a weather observation site to a fire site.

Weather used in FPA

Weather attributes are used to generate the fire event scenario in PCHA.

Topography

Topographic Type

A topographic type is defined as a unique combination of slope, aspect, and elevation.

> **Slope:** Slope steepness is important in predicting fire behavior because the increased preheating of fuels on slopes results in a faster fire spread than on flat ground.
>
> Slope steepness is measured as the number of feet of rise per 100 feet of horizontal distance times 100. Since this measurement is per hundred feet of horizontal distance, it is called slope percent. For example, a slope that has 400 feet of rise for 800 feet horizontally has a slope of 50%.
>
> **Aspect:** Aspect is the cardinal direction a slope faces. It is expressed as flat, north, northeast, east, southeast, south, southwest, west or northwest. Finer gradations based on degrees of the compass can also be used.
>
> **Elevation:** Elevation is the distance above sea level of a spot on the ground. The contours on a topographic map show the elevation above sea level of the land.

Topography in FPA

FPA uses the unique topographic type (slope, aspect, and elevation) in PCHA to help develop the fire event scenario defining fire growth, and in FPA-PM to determine fire line production rates.

Modeling Process for Surface Fire Behavior Including Inputs, Outputs, Limitations, and Assumptions

Fire Spread Model Assumptions and Limitations

It is important to be aware of the limitations and assumptions of the Rothermel Fire Spread Model, since these limitations and assumptions will apply to the spread of a fire event in the FPA-PM fire containment modeling process.

These are:

- Fire behavior is predicted for the flaming front
- Fire is free burning and steady state
- Fine fuels control rate of spread and the models are weighted according to the specific loadings in each fuel size class
- The fuel bed is uniform and continuous
- The fire is a surface fire
- The weather and topography are uniform

Spread model outputs

The primary outputs for use in FPA are the rate of spread and flame length.

> **Rate of Spread:** Rate of spread is the "speed" fire travels through the surface fuels. The rate of spread is the speed of the head of the fire. The rate of spread prediction uses the Rothermel (1972) surface fire spread model, which assumes the weather, topography and fuels remain uniform for the elapsed time of the projection.
>
> **Flame Length:** Flame length is valuable for its correlation with resistance to control, and its impact on fire effects. It is used in FPA to assign a Fire Intensity Level to a fire event.

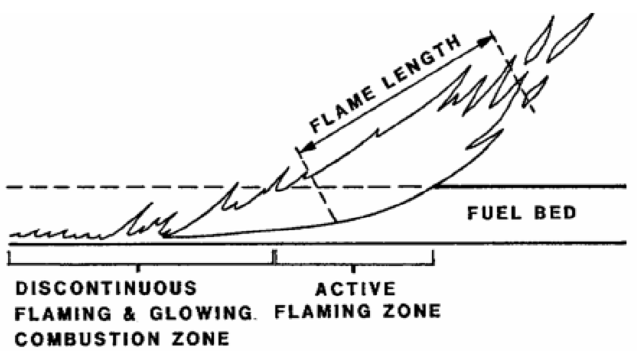

Figure 5: Flame Length

Three Fire Types and Analytical Process Used to Determine When Each is Modeled to Occur

Definitions of Crown and Canopy

- The term crown is used to refer to the foliage and the branch wood for an individual tree.
- The term canopy is used to refer to the collection of crowns within a stand of trees.

Importance of Crown Fire versus Surface Fire Rate of Spread and Flame Length

Rate of Spread: The rate of spread of a crown fire is generally greater than the rate of spread of a surface fire. The crown fire rate of spread can be three to four times faster than the predicted surface rate of spread. This difference is very significant in the fire containment modeling process in FPA-PM.

Flame Length: The greatest difference between surface and crown fire behavior is in the fire intensity as expressed by flame length. The predicted flame length for a passive or active crown fire can be 10-20 times the flame length for a surface fire.

Define Fire Intensity Level (FIL)

Definition of Fire Intensity Level

For FPA, the Fire Intensity Level (FIL) is defined using ranges of flame length. Table 3 lists the correlations between FIL and flame length. In FPA, fire effects are defined by FIL.

The FIL for a fire is determined by the flame length based on the fire's type: surface, passive or active.

Table 3: FIL and Flame Length

Fire Intensity Level	Flame Length
1	0 – 2.0 feet
2	2.1 – 4.0 feet
3	4.1 – 6.0 feet
4	6.1 – 8.0 feet
5	8.1 – 12.0 feet
6	12.1+ feet

Define the Three Fire Types

Surface Fire Type: A surface fire is a fire that burns in the surface fuel layer.

Passive Fire Type: The passive fire type is what is traditionally called torching. It is small scale, consuming single or small groups of trees or bushes. This stage of a crown fire reinforces the spread of the fire, but the main fire spread is still dependent upon surface fire behavior.

Active Fire Type: An active fire type is associated with a pulsing spread. The surface fire ignites crowns. The fire spreads in the crowns faster than on the surface. After a distance, the crown fire weakens due to a lack of reinforcing surface fire heat. When the surface fire catches up to the point where the crown fire died, the surface fire intensity may again initiate a crown fire pulse.

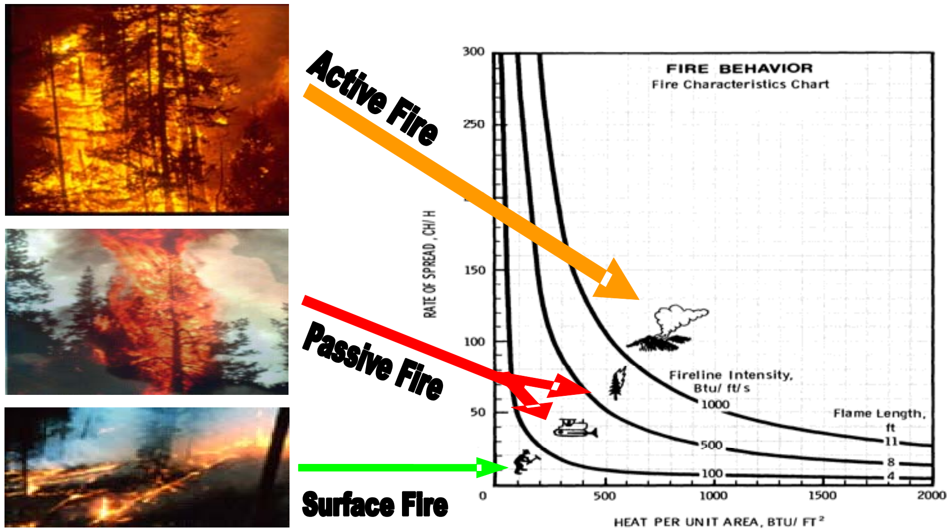

Figure 6: The Three Wildfire Types

For a description of crown fire modeling, see *Assessing Crown Fire Potential by Linking Models of Surface and Crown Fire Behavior* (Scott and Reinhard, RMRS-RP-29, 2001)

Use of the Fire Behavior Prediction System (FBPS) and the National Fire Danger Rating System (NFDRS) Components in FPA

Outputs of FBPS and NFDRS

Table 4 shows some FBPS outputs and NFDRS indices that are calculated by identical or similar equations.

Table 4: FPBS Outputs and NFDRS Indices

FBPS Output	NFDRS Output
Rate of Spread	Spread Component
Flame Length	Burning Index
Reaction Intensity	Energy Release Component

NFDRS Indices Used in FPA

Spread Component (SC)

The Spread Component is a rating of the forward rate of spread of a head fire. Deeming, et al. (1977), states, "…the spread component is numerically equal to the theoretical ideal rate of spread expressed in feet-per-minute…" This carefully worded statement indicates both guidelines (it is theoretical) and caution (it is ideal) must be used when applying the Spread Component. Wind speed and slope are key inputs in the calculation of the Spread Component, accounting for high variability from day to day. The Spread Component is expressed on an open-ended scale, thus it has no upper limit.

Energy Release Component (ERC)

The Energy Release Component is a number related to the available energy (BTU) per unit area (square foot) within the flaming front at the head of a fire. Daily variations in ERC are due to changes in moisture content of the various fuels present, both live and dead. Since this number represents the potential "heat release" per unit area in the flaming zone, it can provide guidance to several important fire activities. It may also be considered a composite fuel moisture value as it reflects the contribution that all live and dead fuels have to potential fire intensity. It should also be pointed out that the ERC is a cumulative or "build-up" type of index. As live fuels cure and dead fuels dry, the ERC values get higher, providing a good reflection of drought conditions. The scale is open-ended or unlimited and, as with other NFDRS components, is relative. Conditions producing an ERC value of 24 represent a potential heat release twice that of conditions resulting in an ERC value of 12.

Burning Index (BI)

The Burning Index is a number related to the contribution of fire behavior to the effort of containing a fire. The BI is derived from a combination of Spread and Energy Release Components. It is expressed as a numeric value closely related to the flame length in feet multiplied by 10. The scale is open-ended which allows the range of numbers to adequately define fire problems, even in times of low to moderate fire danger.

For more information on NFDRS read the NFES publication 2665, *Gaining an Understanding of the National Fire Danger Rating System*.

Uses of FBPS and NFDRS in FPA

FBPS is used for real time fire behavior prediction.

NFDRS is used for broad area fire danger rating assessments. Even though the NFDRS uses equations identical to or similar to the ones used in the FBPS to calculate indices such as Spread Component, these indices are for relative assessment for fire danger only.

FPA uses the weather values contained in NFDRS weather records to provide the FBPS equations required weather information to make spread calculations.

Importance of the Fire Behavior Prediction Process in FPA-PM

FBPS Processors

Nomograms, tables or software programs (e.g. BehavePlus, FARSITE) can be used to calculate fire behavior outputs such as rate of spread and flame length. Because the predictions are based on mathematical models that include some simplifying assumptions, one must judge the applicability of the results according to how closely the model outputs predict the real situation. Each of these FBPS processors may be downloaded from http://www.fire.org/

Real World Fire Situations

The use of the FBPS is primarily for generating site-specific fire behavior predictions for wildfires. The accuracy of predictions is highly dependent on the ability to verify and calibrate predictions through real time observations on the fire.

The Advanced Wildland Fire Behavior Calculations course (S-490) has units that teach the value of the process of verifying fire behavior predictions with real time observations.

The FARSITE program has the ability to assign a calibration factor, which is used to change the predicted rate of spread outputs to more closely match the observed rate of spread outputs. This factor is used only after all other user and data error sources have been examined. The calibration factor works well in the real time fire behavior prediction mode.

Use in FPA

In PCHA, the rate of spread and flame length assigned to a fire event are not changed by a calibration factor, and generally over predicted fire spread.

Importance of Input Values for Attributes of the Topographic and Fuel Types

Use of the predicted rate of spread and flame length place additional emphasis on the accuracy of FBPS inputs for weather, fuels and topography. It will be of great value for a member of the FPU planning team to have advanced fire behavior and prediction experience on fires. Use of available utilities and software to verify fire behavior outputs from fuel type and weather inputs will support the validity of outputs for the FPA planning process.

Fire Containment Process Used In FPA-PM

Definition of Fire Containment as used in FPA-PM

A fire is modeled as contained in FPA when the fireline produced by the initial response resources is greater than or equal to the fire perimeter. The time at which this occurs is called the fire containment time. At this moment, the effective forward spread of the fire has been halted and the fire size is determined. Note that work is still necessary to mop up the fire.

Figure 7 shows an example for a fire with one engine providing initial attack on a fire. The engine arrives at time T1. It runs out of water and leaves line cutters behind at times T2 and T4. It returns full of water at times T3 and T5. The fire is contained at time T6 when the total fireline produced is equal to the perimeter of the fire.

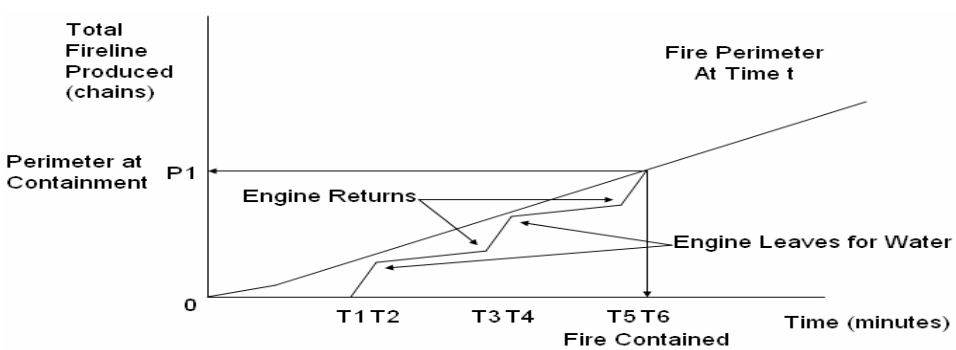

Figure 7: Example Fire Spread

Elliptical Fire Shape

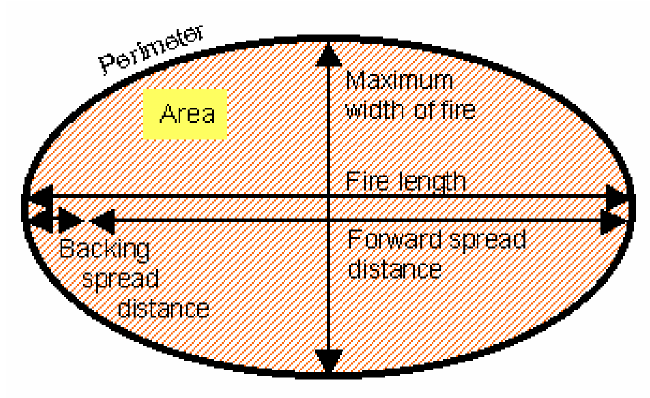

Figure 8: Fire Shape

Elliptical Shape

The shape of the fire is based on the FBPS elliptically shaped fire model. It assumes the fire started from a point source. Calculations are based on rate of spread, effective wind speed, and elapsed time.

Transition to the Steady State Rate of Spread

In fire growth modeling, there is a transition period from the fire start until the fire's rate of spread is assumed to be in a steady state condition. This transition period is based on the surface fuel model the fire is burning in.

Fire Size and Perimeter

The elliptical fire shape model determines the fire size and perimeter at a given time.

Wind Speed

FPA assumes a constant wind speed of 7.2 mph

FPA-PM White Paper Overview

A White Paper is a publication that states a position on a social, political, or other subject, often including a high-level explanation of an architecture or framework for a solution. A White Paper often explains the results or conclusions of research. There are several white papers pertaining to the FPA process. You can find White Papers for FPA at http://www.fpa.nifc.gov/Library.htm.

Several of the questions on the Pre-Course Quiz will draw from the following White Papers. Note: this is only a sample of the white paper and memos, guidance, and reports. It may benefit you to read other documents on the FPA website that pertain to your FPU or Agency.

- Implementing Modeled results in the Real World 9/16/05 (PDF | 43kb)
- Developing an Interagency, Landscape-scale Fire Planning Analysis and Budget Tool (a.k.a. Hubbard Report)
- Annual Equipment Operation and Maintenance (O & M) 5/6/05 (PDF | 42kb)
- Defining a Common Attribute revision 7/27/05 (PDF | 39kb)
- Fire Leadership Assumptions 3/10/05 (PDF | 132kb)
- Fire Resource Funding Categories 9/21/04 (PDF | 170kb)
- Fire Support Assumptions 3/10/05 (PDF | 114kb)
- Funding Period for Production Personnel 2/01/05 (PDF | 122kb)
- Unit Threshold for Conducting FPA-PM Analysis 9/20/04 (PDF | 145kb)
- Helitack Deployment 5/16/05 (PDF | 67kb)
- Helicopter Exclusive Use Data 7/28/04 (PDF | 49kb)
- Threat Fires 5/6/05 (PDF | 103kb)
- Line Officer Involvement in FPA

Additional Resources to Help Prepare You for the FPA-PM Training

- FPA Reference Guide
- FPA Glossary
- FPA Technews (contains specific updates to PCHA and FPA-PM applications)
- FPA Newsletters (Quarterly FPA Reports)

Pre-Course Work Quiz

You must submit your quiz answer by the given date defined in your selection letter. Your acceptance into the course will be based on 70% or higher grade on this quiz and completed by the deadline.

Please use the Answer Sheet spreadsheet provided on the FPA website (http://www.fpa.nifc.gov/Implementation/FPA_Pre_Course_Answer_Sheet.xls).
Email the completed answer sheet to **michael_ellsworth@blm.gov.**

The Quiz and Answer Sheet have four parts: FPA Overview, Fuels and Fire Behavior, White Papers Overview, and Gaining and Understanding of NFDRS.

FPA Overview

1. The purpose of the Fire Program Analysis (FPA) System is to ___________?
   a. Provide managers with a common interagency process for fire management planning and budgeting
   b. To evaluate the effectiveness of alternative fire management strategies through time
   c. Meet land management goals and objectives
   d. All of the above
2. At what level is FPA development directed from?
   a. Regional
   b. National
   c. Congress/OMB
   d. Geographic Area
3. What are the six modules planned for the FPA system?
   a. Preparedness, extended attack, large fire, hazardous fuels, prevention/education, and burned area emergency rehabilitation
   b. Initial attack, dispatch, fire leadership, large fire, extended attack, prevention
   c. Initial attack, wildland fire use, large fire, fuels, rehabilitation, and prevention
4. What method will the FPA system use to determine the level of effectiveness?
   a. Optimization
   b. Historic data analysis
   c. Same process as IIAA, FIREPRO, and other legacy software

5. What is the underlining expectation to implementing of the model world vs. the real world
    a. Real world organization should have similar capability to the model world solution
    b. The Real world varying from the Model world does not invalidate the FPA analysis
    c. FPU should expect to implement their fire management program through an organization that is “close” to the optimal solution.
    d. All of the above
6. How should the model results be viewed by modelers and decision makers?
    a. Absolute answers
    b. True assessment of the real world
    c. For tactical implementation
    d. A good starting point for discussion
7. What is the biggest philosophical change from existing legacy models to FPA?
    a. The system is based on measuring performance based on resource values.
    b. The system is based on measuring performance based on monetary values.
    c. Evaluate performance based on WAM vs. cost at different cost limits.
    d. The way the economic model works in evaluating performance at a range of resource mixes.
8. What are the three elements of the new philosophy
    a. Single interagency system
    b. Performance-based planning and budgeting
    c. Optimization programming
    d. All of the above
9. What is the definition of Weighted Acres Managed (WAM)
    a. Weighted acres improved through initial attack and weighted acres protected through wildland fire use.
    b. Weighted acres protected through initial attack and weighted acres improved through use of wildland fire.
    c. Weighted acre attributes improved through cost efficient resource deployment.

Fuels and Fire Behavior

10. Fuel is: (choose one)
    a. Any organic material that is living or dead, that can ignite and burn
    b. Only dead organic material that can dry out and burn
    c. Any organic material that is on the surface of the ground
    d. Elevated material like tree crowns
11. What are the three fuel categories
    a. Duff, brush, tree
    b. Ground, surface, aerial
    c. Soil, leaves, surface
    d. Surface, passive, active
12. Which one of the following fuel characteristics affects all six-fire behavior elements (ignition, spread, intensity, torching, spotting, crowning).
    a. fuel loading
    b. chemical content
    c. moisture content
    d. orientation
13. Match the following terms to the correct definitions:
    a. ____Live woody fuels
    b. ____Evergreen
    c. ____Deciduous
    d. ____Herbaceous material
    e. ____Perennial
    f. ____Annual

    1. Plants that reproduce from seeds each year
    2. With leaves that remain on the plant for one or more years
    3. Plants that reproduce from a protected plant part like a root or bud and live more than one year.
    4. Those portions of shrubs small enough to burn in the passing flame front. Includes leaves and fine twigs less than 1/4 inch in diameter.
    5. Plants that loose their leaves each year
    6. Live portions of grasses and forbs
14. List the fuel timelag categories corresponding to **1-hr**, **10-hr**, **100-hr**, and **1000-hr,**
    a. 0-¼, ¼-1, 1-3, 3-8
    b. 0-1, 1-2, 2-5, 5-8
    c. 0-¼, ¼-½, ½-1, 1-3
    d. 0-¼, ¼-3, 3-8, >8

15. What is the definition of canopy bulk density?
    a. The height above the ground of the first canopy layer where the density of the crown mass within the layer is high enough to support vertical movement of a fire
    b. Canopy biomass divided by the volume occupied by crown fuels
    c. The average measurement of the height of the trees in the stand
    d. All the above
    e. None of the above
16. Slope affects fuel availability to burn because:
    a. Fuels are preheated upslope through radiation and convection.
    b. Fire Behavior is greater on slope then flat ground.
    c. Drier sites are more prevalent on steeper slopes.
    d. Both (a) and (b) are correct
17. On what aspect would the lowest relative humidity be normally found?
    a. East
    b. Southeast
    c. West
    d. Southwest
18. Select the correct statement regarding the topographic type and its effect on wildland fire behavior.
    a. The topography seldom modifies the weather or the curing time of fuels.
    b. The topography has a minor effect on wind speed and direction and does not affect the curing time of fuels.
    c. The topography can influence the curing of fuels as well as the intensity and spread of wildland fires.
    d. The topography is an effective barrier to fire spread.
19. A fuel model is best defined as:
    a. An exact representation of real world fuels
    b. Mathematical description of a fuel particle
    c. A stylized set of physical parameters of fuels
    d. A set of parameters which define fuel input to the fire spread model
20. In selecting a fuel model, it is important first to assess:
    a. Fuel loading
    b. Fuel moisture
    c. The primary fuel that carries the fire
    d. Fuel chemistry

21. Fire Behavior Prediction System (FBPS) is designed for __________ application?
    a. Landscape scale
    b. Site specific
    c. Short term
    d. Both a, and c
22. Which FBPS and NFDRS outputs does FPA-PM use?
    a. SC, flame length
    b. Probability of ignition, ERC
    c. Crown bulk density, BI
    d. Rate of spread, ERC
23. The four fuel factors that affect the ignition of wildland fires are:
    a. Size and shape of fuel, topography, wind, fuel temperature
    b. Fuel temperature, fuel moisture, wind, and intensity
    c. Size and shape of fuels, compactness or arrangement of fuels, fuel moisture, and fuel temperature.
    d. Compactness or arrangement of fuels, topography, intensity, fuel moisture
24. Fire behavior prediction and fire danger rating have four fuel model types in common. They are:
    a. Herbs, grass, timber litter, slash
    b. Grass, forbs, conifers, slash
    c. Perennials, brush, timber litter, slash
    d. Grass, brush, timber litter, slash
25. A fuel type used in FPA is a combination of :
    a. Canopy cover, surface fuel model, canopy base height, canopy bulk density, stand height
    b. Canopy, fuel model, slope, aspect, elevation
    c. Canopy cover, fuel type, canopy base height, canopy bulk density, stand height
26. The Primary inputs that affect rate of spread are:
    a. Wind speed, barriers, and steepness of slope.
    b. Changes in fuel type, wind speed, and steepness of slope
    c. Fire whirls, barriers, and wind speed.
    d. None of the above
27. The three stages of fire development include:
    a. Independent, wind driven and plume dominated
    b. Surface, passive, and active
    c. Dependent, codependent and independent
    d. Surface, aerial and independent

28. Weather, Fuel, and Topography are used in FPA-PM for __________?
    a. Generating the fire event scenario in PCHA
    b. Fire line production rates
    c. Defining the Fire Intensity Level (FIL)
    d. All of the above

White Papers Overview (all white papers are at www.fpa.nifc.gov/Library/)

29. Who originated the *Developing an Interagency, Landscape-scale Fire Planning Analysis and Budget Tool* paper?
    a. Office of Management and Budget to the Departments of Interior and Agriculture
    b. Department of Interior
    c. Department of Agriculture
    d. National Wildfire Coordinating Group
30. Are annual equipment operations and maintenance (O&M) included in FPA-PM? If so, what is included? If not, what are the implications of not including O&M?
    a. Yes. Equivalent lease rates are used.
    b. Yes. O&M includes Annual Rental Cost (FOR) and Minimum Annual Use Cost
    c. No.
    d. No, but it is included in BDD.
31. How are weighted acres managed (WAM) compared between FPUs?
    a. weights are equivalent between FPUs
    b. all weights are created equal
    c. weights aren't compared between FPUs
    d. weights are based around a common currency
32. The common currency used by FPA is_______?
    a. Wilderness
    b. Wildland Urban Interface
    c. Wildland Fire Use
    d. Weighted Acres Managed
33. Can Fire Leadership be shared across agency boundaries in FPA-PM?
    a. No. This is done in BDD.
    b. Yes. Fractional Positions are used.
    c. No. Positions are agency specific and the FPU team proportions out the costs.
    d. Yes. Costs are selected from Table A-13

34. What is a “non-budgeted” resource?
    a. Non-budgeted resources are primarily funded through Preparedness Activity.
    b. Non-budgeted resources are associated with the FPU being analyzed
    c. Non-budgeted resources are not funded from Preparedness Activity
    d. Federal crews funded by hazardous fuels monies
    e. B, C and D are correct.
35. How is a “non-budgeted” resource different from a “loaned” resource?
    a. Loaned resources may come from outside of the FPU
    b. Loaned resources may be funded by Wildland Fire Appropriation (Preparedness Activity), but in a different FPU than the analysis FPU.
    c. Loaned resources may include smokejumpers and airtankers
    d. Loaned resources may be physically located within the FPU being analyzed.
    e. All of the above are correct.
36. How does the Manage Budget function in FPA-PM ensure that fire planners, cache personnel, training/safety personnel, and dispatchers are funded?
    a. “Fire Support” funds are used to “buy” these staff
    b. A one-size-fits-all menu has been developed to restrict choices in the Manage Budget tab.
    c. A pick-list allows for refining choices to better reflect different agency needs and missions.
    d. A and C are correct.
37. How is the preparedness season for FPA-PM calculated?
    a. This is the group of sensitivity periods when fire ignition occurrence is typically highest
    b. This is the time of year when additional staffing resources are required to manage both initial attack and initial response
    c. It is the period of the year when damaging wildfires are infrequent
    d. A and B are correct
38. Does FPA-PM limit its modeling of fires to the preparedness season?
    a. Yes
    b. No
39. When a federal land management unit receives less than $25,000 in annual Fire Program funding, the unit automatically is excluded from the FPA analysis
    a. True
    b. False

40. Open the Sierra Example spreadsheet at the following website (http://taurus.cnr.colostate.edu/projects/fel/pdf/fpa/SierraExample.xls), and turn to the IA Weights worksheet (tab at the bottom of the page).
    What happens to the Weights as Integers Numbers for FMU 15 when you change the Implicit Attribute Price (the numbers in green) for Rangeland, in FIL 4-6 from 0.30 to 1.0 (making the protection of rangeland equivalent in importance to the protection of WUI)? Note this and change the value back to 0.30 and the Weight as integer should return to its original value.
    a. it goes from 200 to 2000
    b. it goes from 78 to 79
    c. it goes from 54 to 55
    d. none of the above are correct
41. FMU 15 has 40,000 burnable acres. 200 of these are in Rangeland. With the IAP (Implicit Attribute Price) set to 0.30, change the number of rangeland acres represented in this FMU from 200 to 2000. Then change the value to 20,000. What happens to the Weights as Integers numbers?
    a. it goes from 200 to 2000
    b. it goes from 80 to 93
    c. it goes from 54 to 55
    d. none of the above are correct
42. For FMU 15, reset the Rangeland acres to 200 and the IAP to 0.3, then change the number of acres of WUI (Federal) from 131 to 40,000 for FILs 4-6. What happens to the Weights as Integers numbers?
    a. it goes from 78 to 178
    b. it goes from 78 to 100
    c. it goes from 178 to 78
    d. none of the above are correct
43. What is the most dominant element in the equations that calculate the Weights as Integers numbers? In other words, of the Implicit Attribute Price (IAP), acres influenced by each attribute (e.g., for Federal, or SILVIS WUI for FMU 15 the number of acres influenced is 131), and burnable acres (e.g., for FMU 15, there are 40,000 burnable acres), which is the most important?
    a. the IAP value
    b. the WUI value
    c. the burnable acres in the FMU
    d. the number of acres influenced

44. A limited category helicopter may transport firefighters.
    a. True
    b. False
45. What is the maximum number of shuttles for IA resources when deploying a helitack module in FPA-PM?
    a. Three times
    b. One time
    c. Two times
    d. Unlimited number of times
46. What is the cost of a new helibase?
    a. $105,000
    b. $400,000
    c. $58,500
    d. None of the above
47. A threat fire as defined in FPA is________________?
    a. Any uncontrolled fire near or heading toward an area under organized fire protection
    b. Any uncontrolled fire on state or federal protection threatening private lands
    c. Any uncontrolled fire threatening FPU partner agency lands
    d. Any uncontrolled fire that is not under organized fire protection
48. According to the Threat Fire white paper, historically fires have occurred outside the boundary of the Fire Planning Unit’s Fire Management Units, and are not the primary fire protection responsibility of the Fire Planning Unit participants. How should this set of fires be included in the analysis of the Fire Planning Unit workload?
    a. As threat fires
    b. They should not be included
    c. The “owner” of those fires should be added as an FMU partner
    d. These fires don’t impact the analysis either way
49. The Line Officer Involvement in FPA white paper outlines what the role of the Line Officer should play in the FPA process. What is their main role?
    a. To ensure their agency was fairly represented in the analysis
    b. To be an FPU administrator
    c. To participate in developing the FPU and FMU
    d. To develop an FPU charter

Gaining an Understanding of the NFDRS

50. Fire danger predictions are___________, while fire behavior predictions are_____________.
    a. Broad scale, site-specific
    b. Site-specific, broad scale
    c. Short-term, long-term
    d. Absolute, relative
51. What is the definition of fire danger?
    a. The resultant descriptor of the combination of both constant and variable factors which affect the initiation, spread, and difficulty of control of wildfires on an area.
    b. Smokey Bear's hand on a billboard
    c. A description of constant and variable factors in the environment that drive the assumptions in the model
52. If an NFDRS component doubles, the projected workload measured ____________?
    a. increases
    b. doubles
    c. trebles
    d. remains constant
53. The assumptions within NFDRS are:
    a. Outputs relate only to the potential of an initiating fire, one that spreads without crowning or spotting, through continuous fuels on a uniform slope.
    b. Outputs address fire activity from a containment standpoint as opposed to full extinguishment.
    c. The ratings are relative, not absolute and they are linearly related.
    d. Ratings represent near worst-case conditions measured at exposed locations at or near the peak of the normal burning period.
    e. All of the above
54. The acronym used for naming the national fire weather archive to manage weather is:
    a. WIMS
    b. NIFMID
    c. NFDRS
    d. KCFAST
55. NFDRS calculations are normally done on weather observations taken at:
    a. 1300 hours LST
    b. 1400 hours LST
    c. 1500 hours LST
    d. 1600 hours LST

56. 1000-Hr modeled fuel moisture content is represented by:
    a. Dead fuels between 3” and 8” diameter in the fuel bed
    b. Live and dead fuels between 3” and 8” diameter in the fuel bed
    c. Dead fuels between 3” and 8” diameter and/or the layer of forest floor about 4” below the surface of the forest floor
    d. Duff material more than 4” below the surface of the forest floor
57. Match the NFDRS indices or component with the definition provided.

a. ____Ignition Component	1. A rating of the potential forward rate of spread of a fire
b. ____Spread Component	2. A number related to the potential available energy per unit area at the head of a fire.
c. ____ Burning Index	3. The probability that a firebrand will cause a fire requiring suppression action
d. ____Energy Release Component	4. A value related to Flame Length (times 10)

58. Burning Index is a combination of which NFDRS components?
    a. ERC and IC
    b. ERC and BI
    c. ERC and SC
    d. ERC and KBDI
59. Which NFDRS index or component is relatively stable and is considered the best choice for use in planning decisions?
    a. BI
    b. 1000-hr
    c. ERC
    d. KBDI
60. What is the name of the national interagency software program used to evaluate and manage archived fire weather data?
    a. Personal Computer Historic Analysis (PCHA)
    b. FireFamily Plus (FF+)
    c. Fire Weather Plus (FW+)
    d. Behave Plus
61. NFDRS applications that produce daily assessments require:
    a. Uniform standards
    b. Archived records
    c. Quality control
    d. Both a. and c.

Please use the Answer Sheet spreadsheet provided on the FPA website (Pre-Course Answer Sheet). Email Answers to **michael_ellsworth@blm.gov**. Call (208) 947-3769 with questions